

Model Workflow

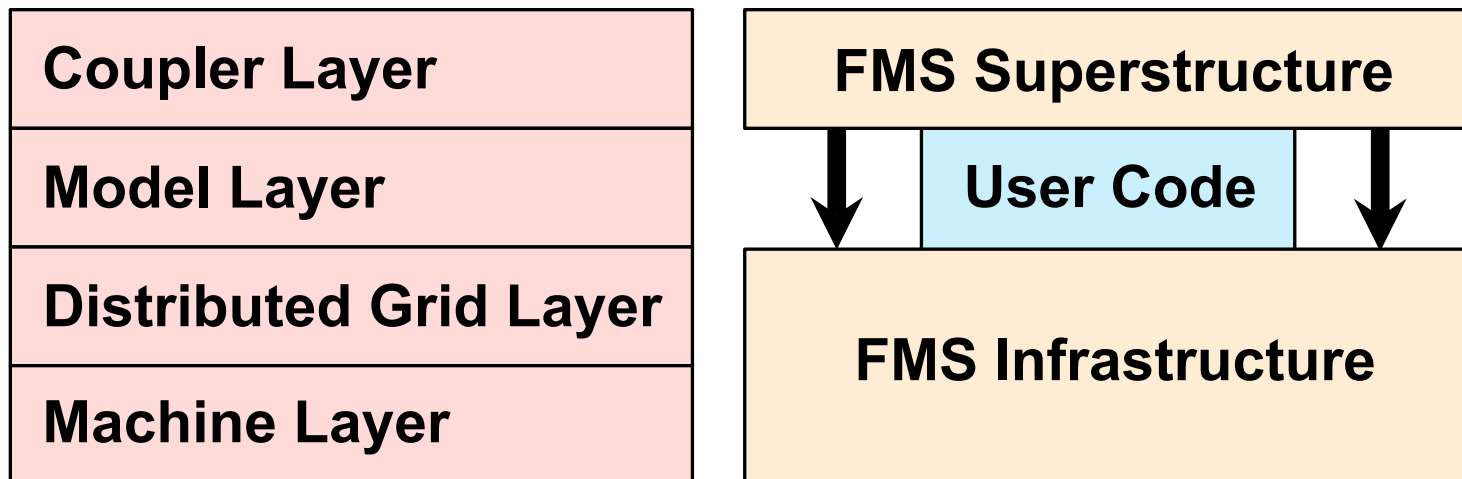
Amy Langenhorst
Summer School 2012

Outline: Model Workflow

- **Intro to FMS and FRE**
- Workflow Basics
- FRE Features and Components
- FRE Job Streams
- FRE Archived Output
- FRE Utilities
- FRE XML Overview

Flexible Modeling System

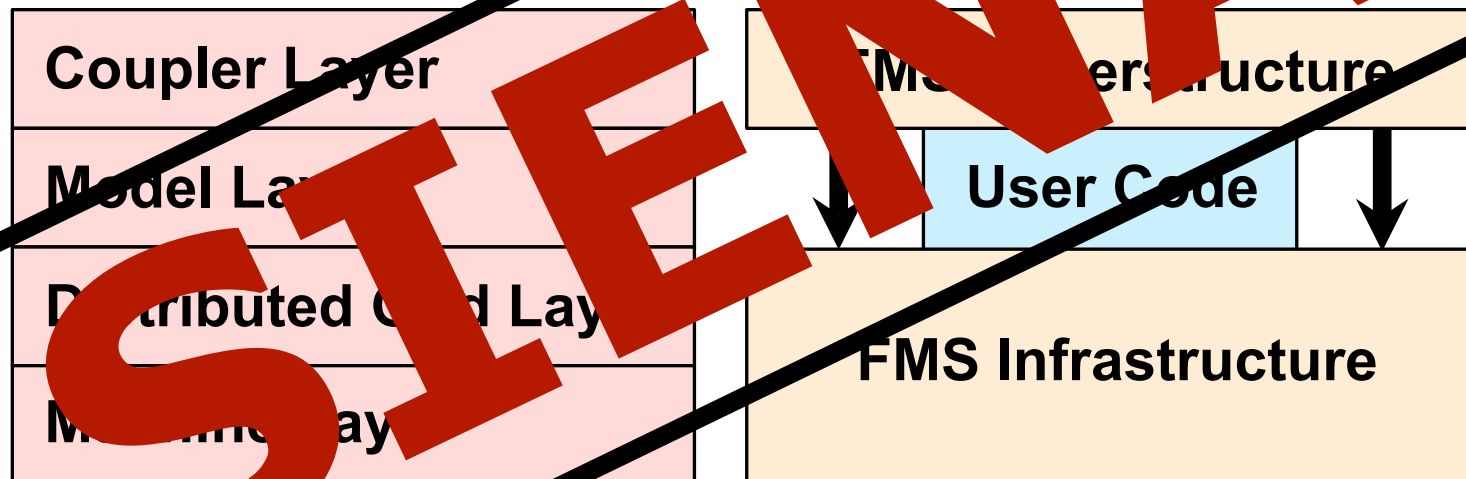
- FMS is a software framework which provides infrastructure and interfaces to component models and multi-component models.



- Development timelines:
 - Component models by scientific group, continuous
 - Annual FMS city releases, 200+ configurations tested

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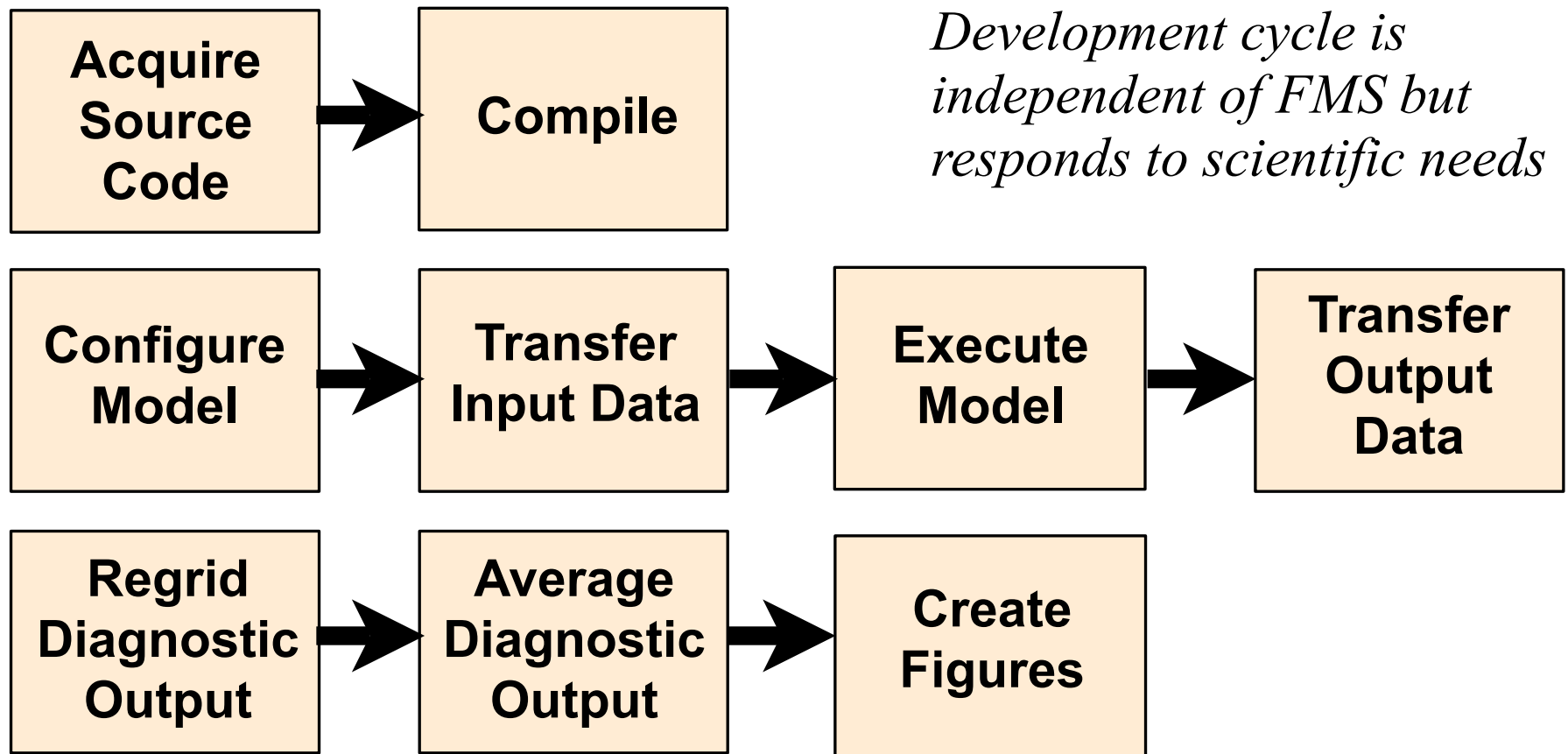
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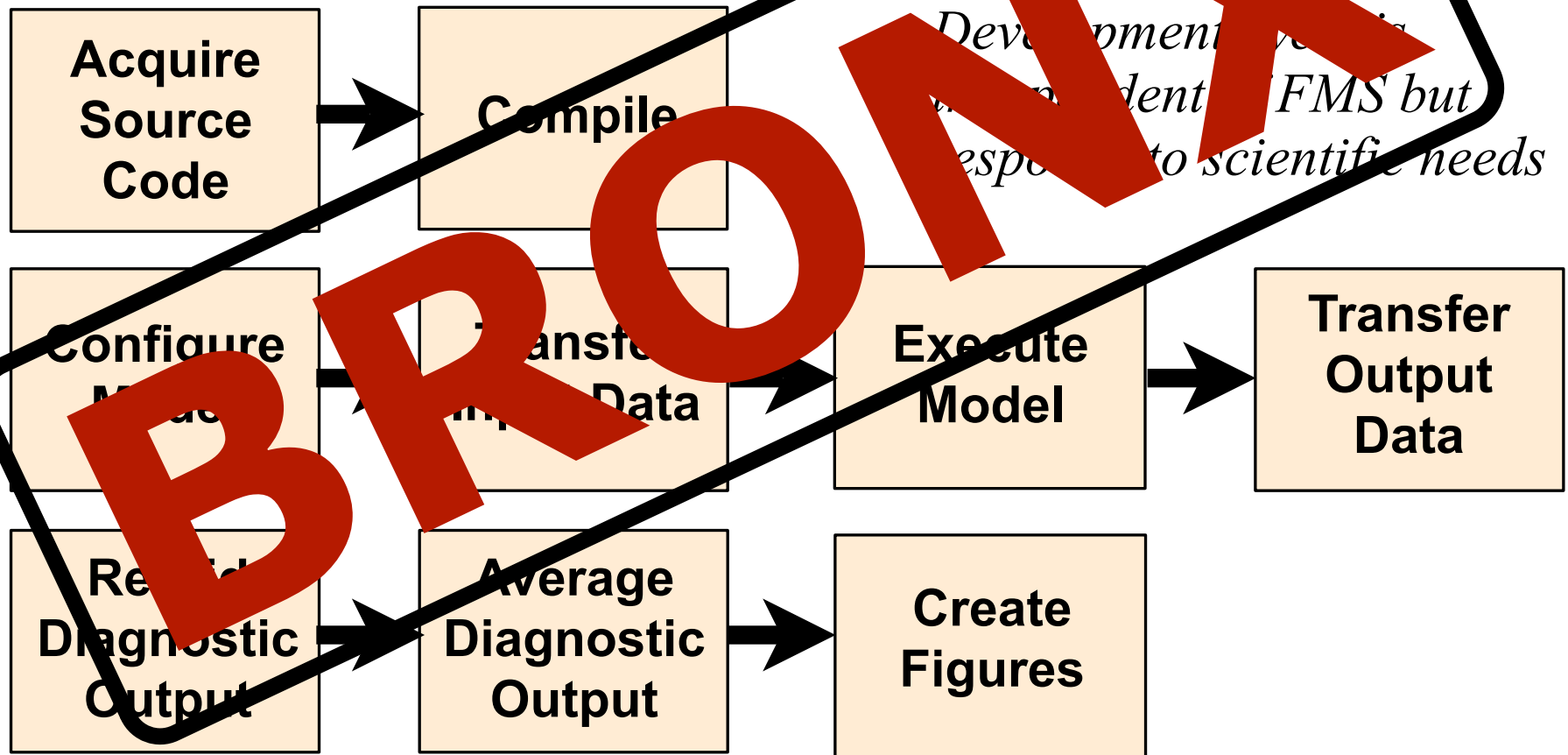
FMS Runtime Environment

- FRE is a set of workflow management tools that read a model configuration file and take various actions.



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Workflow

- A workflow is a comprehensive but precise description of a sequence of actions
 - reproducibility
 - perturbations
 - differencing
 - error handling: user level & system level
- A typical workflow of CM2.5, one of our larger climate models, uses 1.6 million core hours and produces 13 TB of data in the course of a 100 year run.

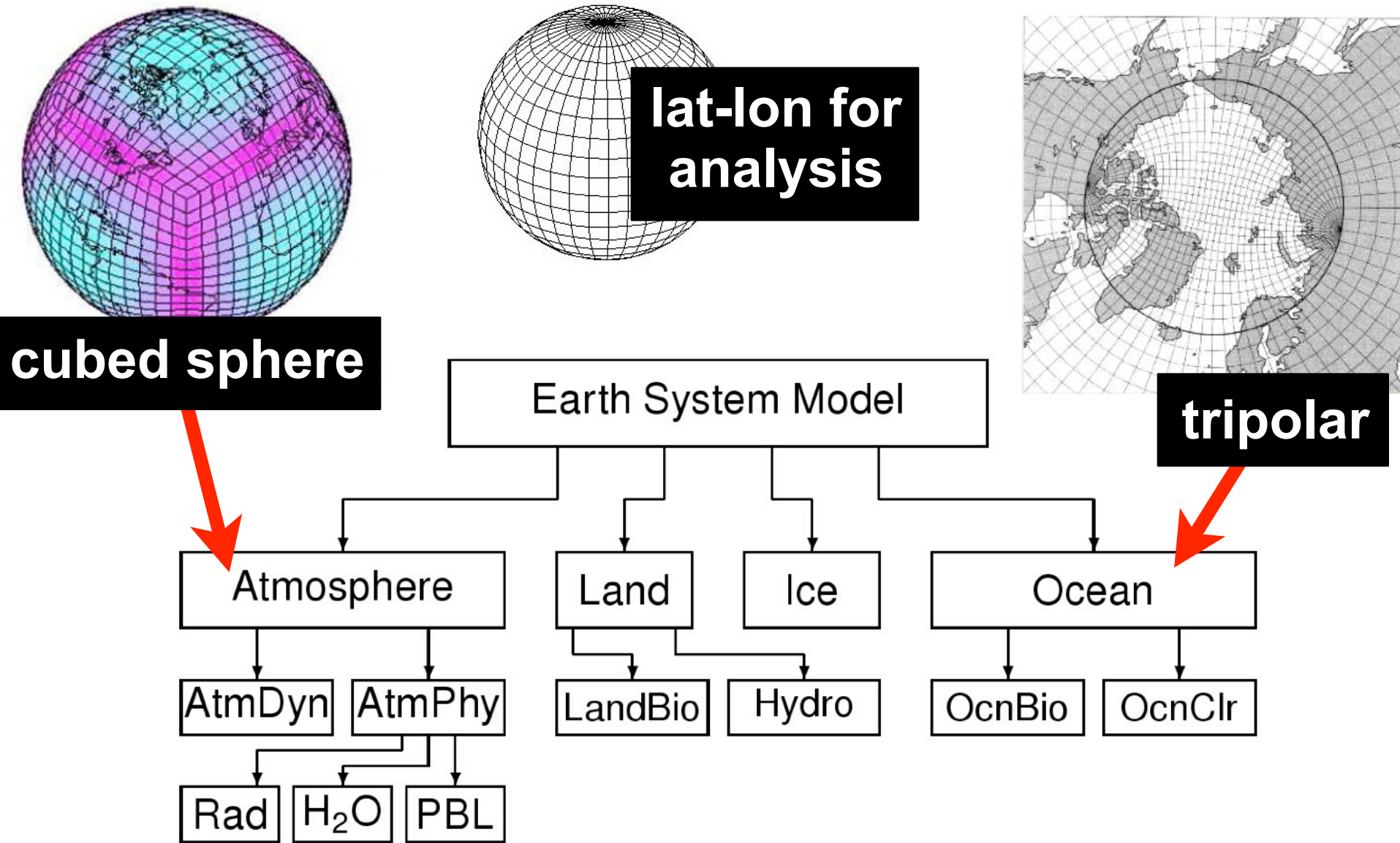
Climate Model Workflow

- Source code version control
- Model configuration management
- Building executables
- Control of model execution
- Monitoring (job level and model level)
- Post-processing
- Archiving
- Automated analysis
- Entry into curator database

Post-processing Defined

- Preparing diagnostic output for analysis
 - Time series
 - Hourly, daily, monthly, seasonal, annual
 - Climatological averages
 - For example, an average of ten Januaries
 - Horizontal interpolation: cubed sphere data can be regridded to lat-lon
 - Vertical interpolation: pressure levels
 - Hooks to call user scripts to create plots or perform further data manipulation
 - Enter the model into the curator database

Components and Grids



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FRE Features

- Encapsulated support for multiple sites
 - compiler, batch scheduler, utility paths, user defaults
 - simple: a linux workstation
 - complex, parallel and distributed: remote computing on a 100,000 processor Cray at ORNL with local data archiving and post-processing
- Model component-based organization
- Integrated model testing
- Experiment inheritance for perturbations
- Standard post-processing functions and user-level functions

FRE Workflow Components

- XML Model Description File
 - contains a complete description of one or more experiments
- Command line utilities read XML file
- Site configuration files
 - script templates
 - standards and conventions for file names and locations
- FRE version management with environment modules

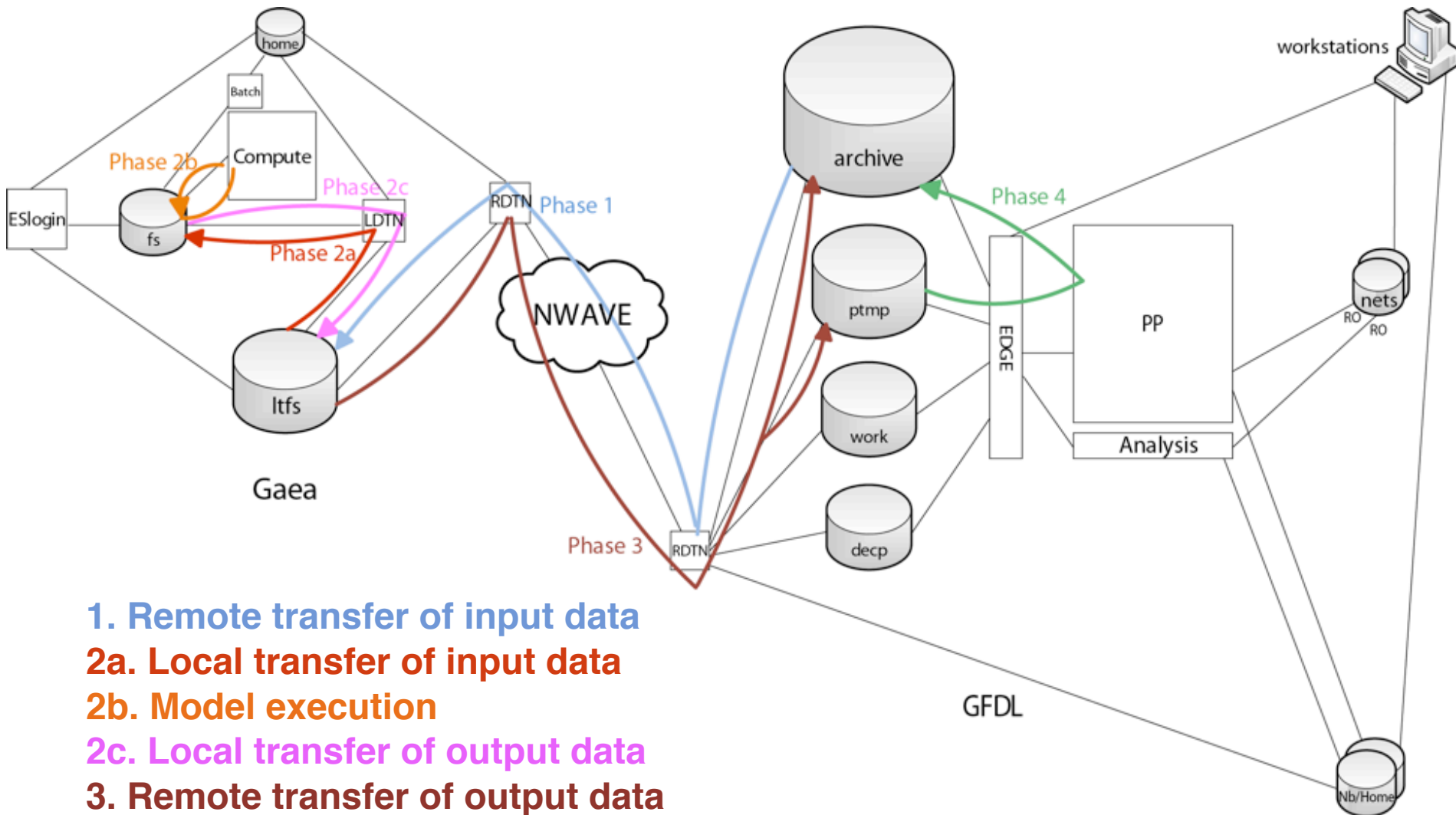
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FRE Job Stream Overview

- Experiments run in segments of model time
 - Segment length is user-defined
 - More than one segment per main compute job is possible
- After each segment:
 - the state is saved
 - data is transferred to long term storage
 - a number of post-processing jobs may be launched to operate on the data in parallel

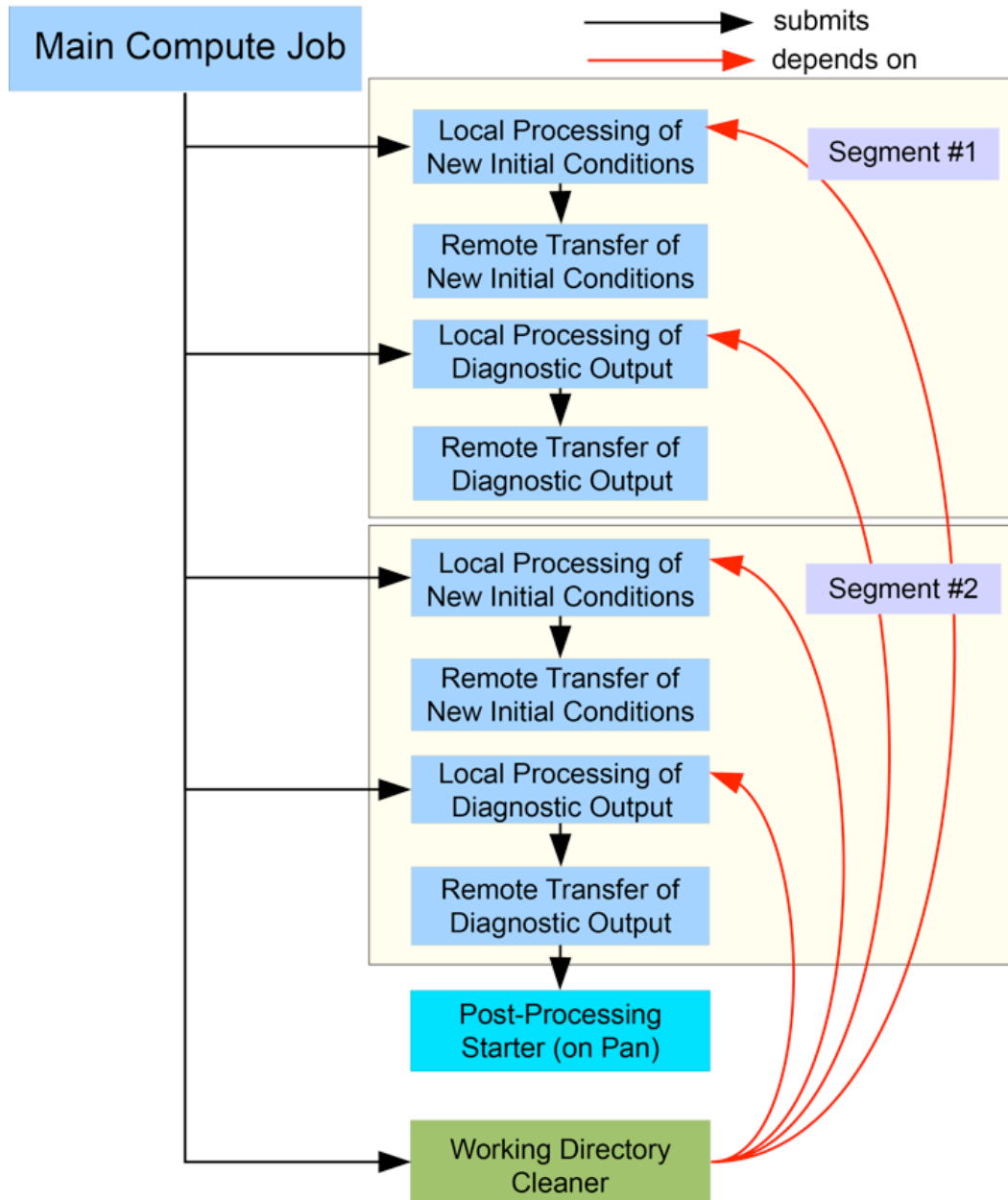
Flow Through The Hardware



1. Remote transfer of input data
- 2a. Local transfer of input data
- 2b. Model execution
- 2c. Local transfer of output data
3. Remote transfer of output data
4. Post-processing

FRE Job Stream

Two-segment job with post-processing in **chained** mode



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Archived Output

```
/archive/$USER/fre/CM2.1U_Control-1990_E1.M_3A
|-- ascii
|-- restart
|-- history
`-- pp
    |-- atmos
    |   |-- ts
    |   |   |-- monthly
    |   |   |   |-- 5yr
    |   |   |       |-- atmos.000101-000512.mon.nc.cpio
    |   |   |       |-- atmos.000601-001012.mon.nc.cpio
    |   |-- av
    |   |   |-- monthly_5yr
    |   |   |   |-- atmos.0001-0005.01.nc
    |   |   |   |-- atmos.0001-0005.02.nc
    |   ...
    ...
```

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FRE Utilities

fremake: obtain code, create/submit compile scripts

frerun: create and submit run scripts

frepp: create and submit post-processing scripts

frelist: list info about experiments in an xml file

frestatus: show status of batch compiles and runs

frecheck: compare regression test runs

frepriority: change batch queue information

freppcheck: report missing post-processing files

refrepp: submit jobs to generate missing pp files

frescrub: delete duplicate post-processing files

freconvert: convert XML to a newer version

fredb: interact with Curator Database

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Sample XML: Setup

```
<experimentSuite>
  <setup>
    <platform name="gfdl.default">
      <directory stem="subdirectory/paths"/>
      <csch>
        module load intel
        module load fre
      </csch>
      <property name="FMS_ARCHIVE_ROOT"
                value="/archive/fms"/>
    </platform>
  </setup>
  <experiment name=""> ...
```


Sample XML: Experiment

```
<experiment name="CM2.5A_2" inherit="CM2.5">
  <component name="fms">
    <source vc="cvs" root="/home/fms/cvs">
      <codeBase version="riga">shared</codeBase>
      <csh>
        cvs up -r riga_arl shared/.../file
      </csh>
    </source>
    <compile>
      <cppDefs> -Duse_netCDF </cppDefs>
    </compile>
  </component>
  <component name="mom4p1"> ...
```

Sample XML: Input

```
<input>
  <namelist name="vert_diff_driver_nml">
    do_conserve_energy = .true.
  </namelist>
  <dataFile label="input" target="INPUT/"
            chksum="" size="" timestamp="">
    $(FMS_ARCHIVE_ROOT)/am2/cover_type_field
  </dataFile>
  <diagTable>
    diagnostic variable table
  </diagTable>
</input>
```

Sample XML: Runs and Jobs

```
<runtime>
  <production simTime="26" units="years"
    npes="120" runTime="12:00:00">
    <segment simTime="12" units="months"
      runTime="06:00:00" />
  </production>
  <regression name="basic">
    <run days="8" npes="60" runTime="00:15:00">
  </regression>
  <dataFile label="reference">
    $(FMS_ARCHIVE_ROOT)/am2/riga/19950108.tar
  </dataFile>
</runtime>
```

Sample XML: Postprocessing

```
<postProcess>
  <component type="atmos" source="atmos_month"
    cubicToLatLon="90,144" zInterp="era40">
    <timeSeries freq="monthly"
      chunkLength="10yr">
      <variables> precip, temp </variables>
      <analysis script="/home/template.csh"/>
    </timeSeries>
    <timeAverage source="monthly"
      interval="10yr"/>
  </component>
</postProcess>
```

Questions?

- For more details on FRE, see:

<http://www.gfdl.noaa.gov/fms-fre-usage>

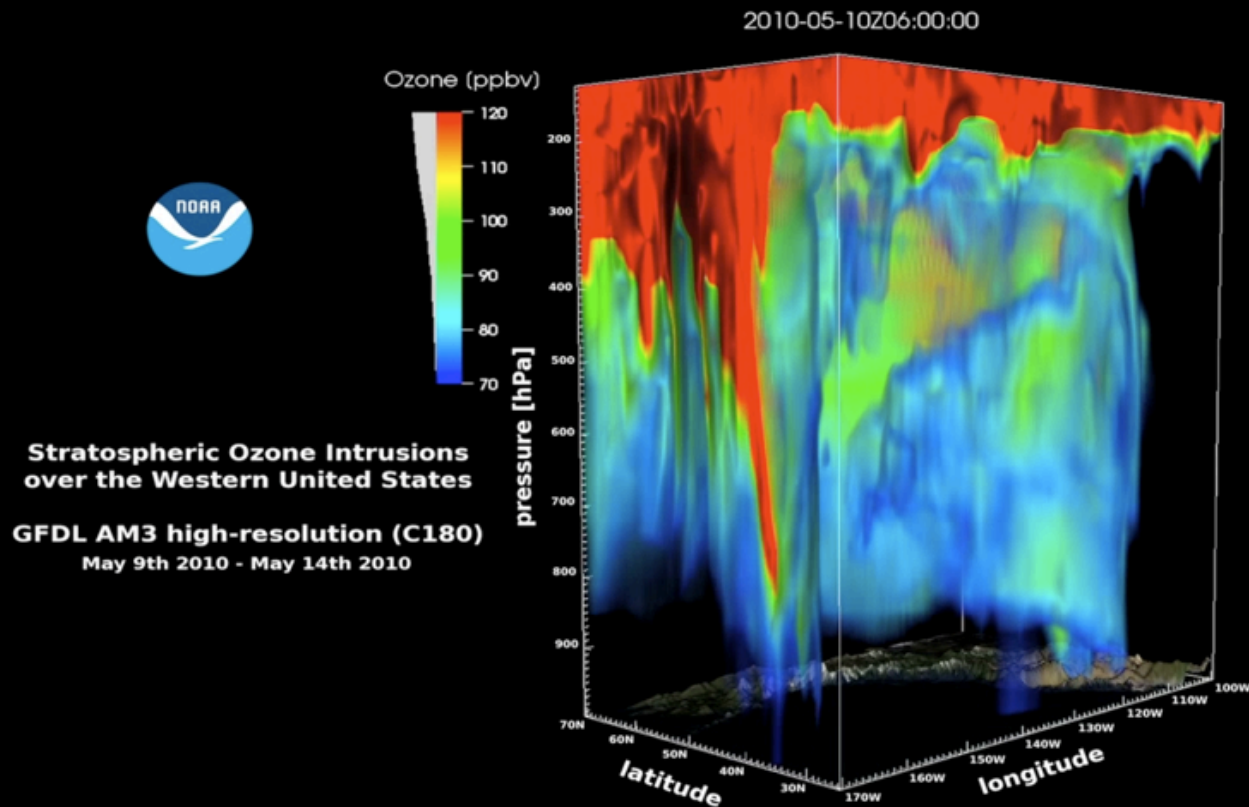


Image by
Simon Su